4th International Entom. Congress, Ithaca, N.Y. 1928

TERMITES MODIFY BUILDING CODES

By Thos. E. Snyder, Senior Entomologist, Bureau of Entomology, U.S. Department of Agriculture, Washington, D. C., U. S. A.

While over 1600 species of termites have been described from various parts of the world and they occur in all zoogeographical regions, except the Arctic, termites of the entire world may be separated into three classes. These divisions are nonsubterranean or dry-wood termites which do not burrow in the ground but attack the wood of buildings directly; subterranean which attack the wood of buildings indirectly from burrows in the earth; and mound or carton tree nest building termites which are also subterranean in habit.

Nonsubterranean termites can be kept out of buildings by proper screening and the use of woodwork and furniture impregnated with standard chemical wood preservatives. When buildings have been attacked by these termites they can be eradicated by fumigating with hydrocyanic-acid gas. Infested furniture can be subjected to heat sufficient to kill the termites without affecting the finish on the wood. Dry-wood termites can also be killed by the use of insecticides or poisons.

Subterranean termites can be kept out of buildings by complete insulation from the ground of all untreated woodwork. No untreated woodwork should be used in basements, cellars, or foundations. Masonry foundations should be capped with a layer of concrete, proper mortar should be used in masonry foundations and metal termite shields should be installed over masonry foundations. The inclusion in mandatory city building codes of a few brief provisions to prevent termite attack is the most practicable method of solving the termite problem; the additional expense of termite-proofing will only be two per cent of the first cost, the expenditure of which may save thousands of dollars in later replacements. This is a form of insurance and should be so recognized by those who finance the erection of structures.

Where mound building termites damage the woodwork of buildings, it may be necessary to poison the termites in the mounds, or destroy the mounds by means of explosives placed in a series of holes in the mound, then the nest material should be broken up, the ground thoroughly plowed and the soil poisoned.

TERMITES MODIFY BUILDING CODES

By Thos. E. Snyder, Senior Entomologist, Bureau of Entomology,
U.S. Department of Agriculture.

Over 1600 species of termites have been described from various parts of the world; this number also includes the subspecies, varieties, forms, etc. The largest number of termites occur in the Ethiopian region; other great centers of distribution are the Neotropical, Oriental, Indomalayan and Australian regions. The smallest number of termites occur in the more temperate Nearctic and Palaearctic regions. The Arctic region is the only zoogeographical region not inhabited by termites.

In portions of most of these regions termites are widespread, occur in great numbers and are of extremely diverse kinds, of widely different habits and habitats. Nevertheless, it is believed that by following proper methods of the construction of buildings the greater portion of damage by termites to the woodwork and contents can be prevented or greatly curtailed.

THREE TYPES OF TERMITES

The termites in this entire world may be separated into three classes, namely: non-subterranean termites which do not burrow in the ground but attack the wood of buildings or trees directly; subterranean termites which attack the wood of buildings, trees or living crops indirectly from burrows in the earth; and mound or carton tree nest building termites which are also subterranean in habit.

NON-SUBTERRANEAN OR DRY-WOOD TERMITES

Non-subterranean or dry-wood termites do not burrow in the ground, but fly to and attack wood directly. (Fig. 1)

Instead of following the grain of the wood continuously, they excavate through it longitudinal chambers of limited length, (fig. 2). The sexual adults, after they have lost their wings, and the young or nymphs, are the destructive forms. Their pellets of excrement are regularly impressed, and sometimes completely fill or block up the burrows in a compact mass; they are often expelled as dry droppings from the infested wood and serve as a warning of infestation. (Fig. 3) These termites are destructive to the woodwork and furniture in buildings, as well as to living trees. They can exist without the great amount of moisture necessary to the life of termites which are subterranean in habit, and can live in wood containing less than the 10% of moisture normally contained in air dried wood.

Fumigation

Fumigation with the very poisonous hydrocyanic-acid gas will kill dry-wood termites infesting the woodwork of buildings and boats. This gas is very dangerous and fumigation with it only done by an expert.* The infested wood should be exposed as much as possible and it may be necessary to open up some of the structure.

---

* 1916 Howard, L. O., and Popenoe, C. N., Hydrocyanic-Acid Gas against Household Insects. Farmers' Bul. 699, U.S. Dept. Agric., Wash., D. C.

Where several stories of buildings are affected, the windows should be sealed and after the fumigation is completed, the rooms should be aired by opening windows with cords from the outside. The usual proportions should be employed; that is, 1 ounce (avoirdupois) of sodium cyanide to 1½ fluid ounces of sulphuric acid and 3 fluid ounces of water; but 12 ounces of the cyanide used per 1000 cubic feet of room capacity, instead of the 10 ounces usually recommended, making the gas 20 per cent stronger. This fumigation will result in the death of the insects within the wood. Fumigation is recommended just before the winged adults fly. At that time these insects are in the outer layers of the wood where they are readily accessible, and the fumigation will destroy large numbers of them - greatly reducing sources of reinfestation.

Furniture infested by these termites can be fumigated in steel cylinders with carbon bisulphid gas, or given heat treatments.

Heat

Temperatures of 130° F. and over can be utilized in killing termites infesting the woodwork of railroad cars, furniture, etc. In Hawaii, a chamber of reinforced concrete, large enough to contain a passenger coach or two freight cars run in on rails was specially constructed. (Fig. 4) The sides of the interior were equipped with coils of piping, live steam from a locomotive was utilized and at 90 pounds pressure it was possible to subject the infested wood to temperatures of 150°F. for at least 1½ hours. The heat was gradually raised and temperatures could be determined

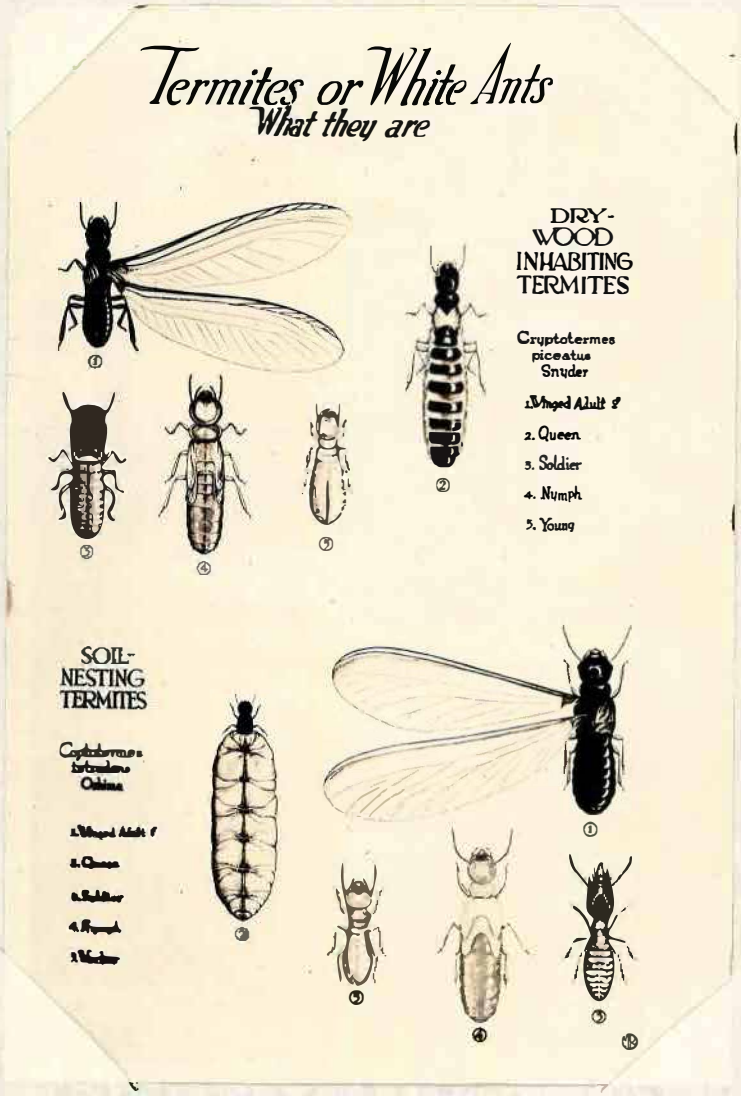


Fig. . Dry-wood or nonsubterranean termite, Cryptotermes piceatus Sny. and subterranean termite Coptotermes formosum Shiraki introduced into the Terr. of Hawaii from the Orient and which must be kept out of California by careful inspection of vessels.

from a thermograph on the exterior of this building. The paint or varnish finish on the wood will not be injured by the heat.

Such a chamber should be located at all ports where wood infested by dry-wood termites or other borers are liable to be introduced and the infested wood subjected to a heat treatment, which is more reliable than fumigation.

Insecticides or Poisons

Poisons can be used to kill nonsubterranean termites within the wood, insecticides useful for this purpose are ortho-dichlorobenzene,* or a 10 per cent solution of kerosene emulsion poisoned by dissolving 1 ounce of sodium arsenite in each gallon of water used for diluting stock mixture of kerosene emulsion or miscible oils. The infested wood is drenched with the insecticide by swabbing with a saturated rag or mop; several treatments may be necessary, and careful watch maintained until it is certain that all the termites are dead.

In Hawaii, dry Paris Green blown into galleries in infested wood with a bellows has been used successfully; where moisture is present this powder cakes and becomes ineffective.

---

* If orthodichlorobenzene is used as a spray, it is advised that the house be opened up, since there is an odor to the chemical which may prove disagreeable in a closed room. Also, in spraying timbers overhead care should be taken not to let the liquid drip down, since it might slightly burn the face and hands and would be especially injurious if it got in the eyes.

Impregnation with Wood Preservatives

In regions where there is much damage caused by dry-wood termites, the buildings should be screened and all woodwork used in buildings should be impregnated with a standard chemical wood-preservative to prevent attack.* This impregnation is made before

---

* 1924. Snyder, T. E., Tests of methods of protecting woods against termites or white ants. Bul. 1231, U.S. Dept. Agric., Wash., D. C.

the wood is placed in the structure and should be given to wood out to exact necessary dimensions. In the case impregnated wood is to be framed after treatment, the out surface should be given a brush or dipping treatment with the hot chemical. Such impregnated wood or timber can be purchased at retail lumber yards in various sections of the United States.

For interior woodwork and furniture an impregnation with ¾ to 1½ pounds of dry zinc chloride salt per cubic foot is recommended. Sodium fluoride and chlorinated naphthalene while more expensive, are also effective preservatives for timber not to be used in contact with the ground, where moisture would cause leaching. These chemicals could be adapted to special, but more limited uses.

Wood-pulp or fiber products, such as the various wood-fiber processed or composition baords, or cane-fiber boards, for interior finish and substitutes for lath (fig. 5), or for exterior use, can be protected from attack by termites by adding certain poisons, such as crude carbolic acid, to the pulp or laminated boards in the course of manufacture. Available poisons for this purpose are crude carbolic acid at the rate of 1 gallon to 1,000 square feet; bichloride of mercury at the rate of 49 ounces per 1,000 square feet; copper sulphate at the rate of 113 ounces per 1,000 square feet; sodium fluoride, sodium fluosilicate, sodium dinitrophenolate or chlorinated naphthalene are also effective poisons for protecting such products from attack by dry-wood termites.

SUBTERRANEAN OR GROUND NESTING TERMITES

Subterranean termites normally live in wood in forests, in plains underneath and in the roots of vegetation or in carton or mound nests. Since termites are soft-bodied they always remain hidden within wood, in the earth or within earth-like shelter tubes. The wingless, sterile workers are the wood-destroying forms. In burrowing in wood the grain is usually followed and the softer wood eaten out. (Fig. 6.)

By man's disturbance of the balance of nature in felling forests, clearing and cultivation of land as well as more extensive building operations, termites have become more destructive to buildings and cultivated trees and crops.

Indications of Infestation

The annual emergence of large numbers of the flying termites is an indication as well as a warning that the woodwork is infested, and the point of emergence indicates the approximate location of the infested timbers. Even if the insects are not observed "swarming", large numbers of the dead winged adults or of the discarded wings usually will be found nearby. Another warning is the presence of branching shelter tubes of small diameter, made of earth mixed with finely digested wood, on foundation timbers, or over the surface of stone, brick, or other impenetrable foundation material, through which the insects travel from the ground to the woodwork. These tubes should be broken off and the ground where they originate broken up and drenched with poison.

Destruction of Breeding Places about the Building Site

If buildings are to be constructed on recently cleared woodland, decaying logs and stumps should be removed from the soil in the vicinity and burned; untreated wooden fence posts, sidewalks, etc., should also be removed. If subterranean termites are numerous in the earth, the soil should be deeply plowed or otherwise broken up and treated with chemicals to kill the insects. Effective poisons for this purpose are calcium or sodium cyanide;*

* For each acre to be treated, dissolve 160 pounds of granular sodium cyanide in 12,000 gallons of water.

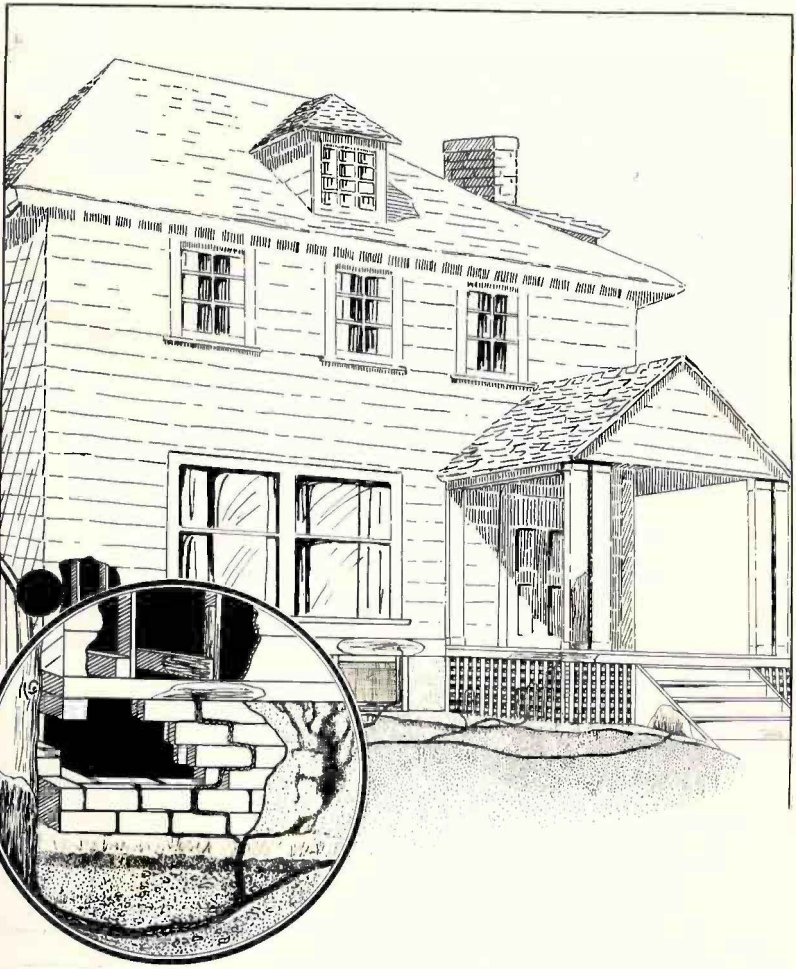
a ten per cent solution of sodium arsenite; 1 part coal-tar creosote and 3 parts kerosene oil (this mixture should be strained through burlap before use); carbon-disulphide emulsion, which is on the market ready for use; orthodichlorobenzene; or other contact poisons or gases. Live steam forced into the soil will serve the same purpose as the gases. The land can also be temporarily flooded to kill termites in the soil.

The presence of termites in the soil can be detected by planting pine or fir trap stakes in the soil. If these are attacked, carbon bisulphid* should be poured into the stake hole, protected

* 1926 Hinds, W. E., Carbon disulphide as an insecticide. Farmers' Bul. 799, U.S. Dept. Agric., Wash., D. C.

by a layer of paper and then covered with dirt. Care should be taken in handling this volatile fluid, as the gas or vaper from it is highly inflammable and explosive when mixed with air in certain proportions; no flame should be brought near it, and the fumes

Fig. 8



should not be inhaled, as they are poisonous.

It may be necessary in tropical countries to lay a base of concrete* for the entire building after the soil has been poisoned.

---

* 1919. Oshima, M. Formosan termites and methods of preventing their damage. Philippine Journal of Science, vol. XV, no. 4, pp. 319-384, Pls. I-XIII

Insulation

Complete insulation from the ground of all untreated woodwork of buildings is the only effective permanent preventive or remedy against attack by subterranean termites. These insects must maintain contact with the ground to obtain the moisture necessary for their existence. When contact with their moisture supply in the earth is cut off, the insects in the damaged wood, no matter how numerous, soon dry up and die.

Concrete Flooring

There should always be a layer of solid concrete at least one inch thick laid over the coarse gravel or cinders or cement grout, base of concrete floors. (Fig. 7) In the tropics concrete floors are advisable for the entire building.

HOW Termites Infest Buildings

The principal methods by which the subterranean termites get into buildings (fig. 8) are:

Untreated wood or fibre products in basements, cellars, or the foundations of buildings, where termite damage is most likely to start.

Termites are able to penetrate masonry walls where improper grades of mortar have been used in foundations, working up through the interior of walls. (Fig. 12[a])

By means of earth-like shelter tubes, termites are also able to crawl up through them over impenetrable walls and thus infest buildings. (Fig. 10)

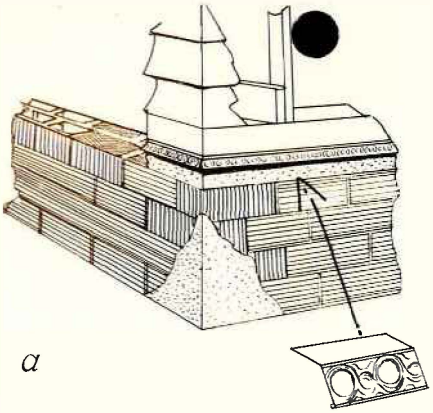
Protection of Basement Construction Essential

Irrespective of whether the proposed building, as to its main construction, is to be of masonry or wood, it is highly desirable, where practicable, to eliminate wood from foundations, cellars, and basements. This means the substitution for wood of concrete or other stone quivalent for basement floorings, as well as the elimination from basements of any other structural wood, including wood substitutes, such as fibre and composition boards and other substitutes containing cellulose. This prohibition does not apply to movable furniture.

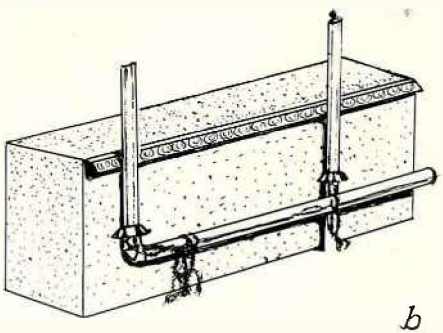
Timber or lumber can be used safely in buildings, where the chief damage is by subterranean termites, if it is raised above possible soil contact a suitable distance by rock, concrete, or brick foundations made with standard grades of mortar, or suitably capped and if metal shields are put on to shut off passage-tubes.

Modification of City Building Codes

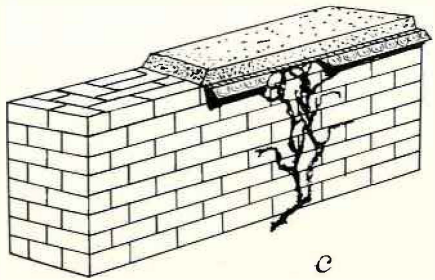
One of the simplest and most effective means of prevention of attack would be to modify the building regulations or codes of various cities so as to include a few simple rules in the mandatory



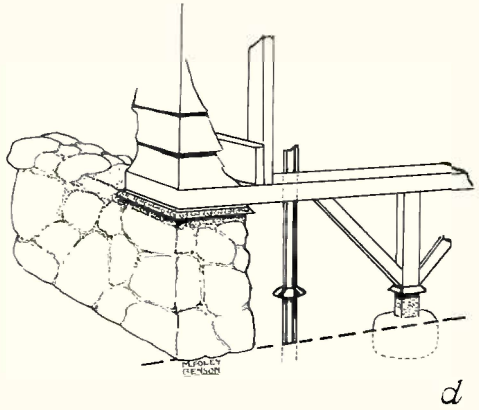
a



b



c



d

Fig. 2. THE INSULATION OF HOLLOW AND SOLID MASONRY FOUNDATION UNITS AGAINST TERMITES

A. Foundation wall of hollow tile surfaced with stucco, showing metal termite shield in place and how the top of the wall is capped with sheet slate and concrete.

B. Concrete wall with termite shield at top and horizontally laid piping fitted with metal shield above bend to shut off termite tubes.

C. Brick wall with termite shield and capped with concrete; note how the shield mechanically blocks the earth-like shelter tubes of the termites.

D. Stone wall with termite shield and capped with concrete and wooden posts insulated from the ground with base stone and concrete block. Note termite shields on post and piping.

code to protect houses from damage by termites. These suggestions are as follows:

PROVISIONS FOR BUILDING CODES FOR INSURING PROTECTION FROM TERMITES AND DECAY

Wood or fiber products, when not impregnated with an approved preservative, shall not be placed in contact with the earth or within 18 inches thereof, excepting wood columns or posts over a concrete floor, which columns shall be provided with noncorroding metal orconcrete base plates or footings 6 inches above the floor. This applies to steps, which shall be laid over a concrete base, projecting at least six inches beyond the supports of the steps.

Timber to be used in contact with the earth shall be thoroughly impregnated by a standard pressure process with coal-tar creosote or other equivalent preservative. Timber should be completely framed before treatment, whenever possible, but when cutting after treatment is unavoidable the cut surfaces shall be thoroughly coated with coal-tar creosote or other equivalent preservative.

Masonry foundations and footings shall be laid in Portland cement mortar. Foundations built up of masonry units, whether hollow or solid, shall be capped below woodwork with at least 1 inch of Portland cement mortar, or the mortar and slate, or solid or joined noncorroding metal, or other equally efficient seal. (Fig. 9)

In the case of frame buildings, a metal termite shield shall be provided, continuing completely around the top of the masonry foundation, including all pillars, supports, and piping, below the woodwork of the building, on both the inside and outside surfaces, to act as a mechanical barrier to the earth-like shelter tubes built by termites. (Fig. 10) Such a shield may be formed of a strip of noncorroding metal (such as copper, zinc, or an alloy of copper 28%, nickel 67%, iron, manganese and silicon 5%) firmly inserted in the surface of the masonry, or between the foundation and the wood, with the projecting edge bent downward at an angle of 45 degrees and extending horizontally at least 2 inches from the face of the foundation. (Fig. 9a) In masonry buildings this shield can be inset in the masonry at a height at least 18 inches above the ground.

Floor sleepers or joists imbedded in masonry or concrete, or laid on concrete which is in contact with the earth, shall be impregnated with an approved preservative.

Expansion joints between concrete floor and wall shall be filled with liquid asphaltum and the right angle joint covered with a sanitary cement mortar or Portland cement concrete finish of an arc of at least 2 inches in length.

The ends of wooden beams or girders entering masonry or concrete shall not be sealed in but shall be provided with boxes affording an air space at the end of the piece of not less than 1 inch at side of member, unless the ends of such timbers are impregnated with coal-tar creosote or other approved preservative.

Where there are spaces under floors near the earth, they shall be excavated so that there will be no earth within 18 inches of the wood, and they shall be provided with cross ventilation. Such ventilating openings shall be proportioned on the basis of 2 square feet for each 25 lineal feet of exterior wall, except that such openings need not be placed in front of such building. Each opening shall be provided with 20-mesh noncorroding metal screening, including windows in attics.

Where timber is used in roofs of the flat type, the roof shall, unless protected on the weather side with a covering impervious to water, have a slope and runoff sufficient to provide proper drainage.

All wooden forms on foundations shall be removed from masonry work within 15 days; grading stakes should be removed before laying concrete floors.

These suggestions will probably add from 1 to 2 per cent to the initial cost of the building (mainly chargeable to supervision), but they are a form of insurance, not only to the householder but to the person financing the building. Bankers have shown their understanding of this point by their willingness to loan more money or give a lower rate of interest to a home owner constructing a building in accordance with these provisions. The requirements are necessarily very brief, practical and reasonable.

The chemical impregnation with standard preservatives of all woodwork to be used in the building where there is considerable damage by dry-wood termites is recommended as a further precaution to persons who can afford the expense of it, but it increases the initial cost 10 per cent.

Cost of Termite-Proofing Slight

A few hundred dollars additional (2 per cent of the first cost) spent in the beginning in proper building construction may save thousands of dollars in repairs and replacements later. It is much simpler and cheaper to keep termites out of a building than to get rid of them and repair the damage after they are once in, involving necessary repairs which may be too costly for the small householder. But certain methods of construction that will prevent injury are entirely practical.

MOUND BUILDING TERMITES

Certain tropical termites build large earthen mound nests of more or less hard texture. By means of subterranean galleries termites from these nests may attack the woodwork of buildings or crops.

The inhabitants of some of these mounds may be poisoned by calcium cyanide or gases such as used with the "Universal Ant Exterminator", or others.

In cases of other mounds, it may be necessary to destroy them by means of explosives* placed in a series of holes drilled in

* 1924. Snyder, T. E. and Zetek, J. Damage by termites in the Canal Zone and Panama and how to prevent it. Bul. 1232, U.S. Dept. Agric., Wash., D. C.

the mound; then the nest material is broken up, the ground ploughed up and the soil poisoned by calcium cyanide (2 ounces per square yard of ground), or sodium arsenite in a 10 per cent solution.

TERMITE RESISTANT WOODS

In view of the fact that but few termite resistant woods occur in the world, it is recommended that, in general, commercial woods grown in the United States be impregnated with standard chemical wood preservatives, rather than to attempt to obtain termite resistant woods.

EXPERIMENTS WITH WOOD PRESERVATIVES

Since 1912, the Bureau of Entomology has been conducting experiments at Falls Church, Virginia, with various chemical wood preservatives to determine the most effective in protecting wood against the attack by termites. Chemical treatments are also being experimented with for wood pulp and fiber products, such as wall-board and the various composition boards all of which are subject to attack by termites.

In addition to the tests conducted in continental United States supplimentary tests were begun in 1924 on Barro Colorado Island, Canal Zone, Panama. Chemical preservative treatments not only for timber in contact with the ground (fig. 14) but also for interior woodwork, cabinet work and furniture are being tested. (Fig. 15)

Todate the most effective chemical preservative treatments for timber in contact with the ground are impregnation with zinc chloride, coal-tar creosote. For timber not in contact with the ground,

impregnation with zinc chloride has proven most effective. These are the standard chemical preservative treatments recommended by the American Wood Preservers' Association.

These experiments are still under way and probably will be continued for many years in the endeavor to discover more effective and cheaper preservatives.

DEMONSTRATION TERMITE-PROOF BUILDING

On Barro Colorado Island, Canal Zone, Panama, a model demonstration termite-proof building (fig. 16) was erected in cooperation with the American Wood Preservers' Association during August, 1926. This building was constructed entirely of wood, all of which had been impregnated before framing with such effective standard preservatives as coal-tar creosote and zinc chloride; the treatments were made by both the full and empty cell pressure processes of impregnation. The treatments selected in each case was that most suitable for the position of the timber or lumber in the structure. Thirty species of wood destroying termites occur on Barro Colorado Island.

On Barro Colorado Island during April, 1927, several buildings and a tower were also erected of redwood (Sequoia sempervirens) of the Pacific Coast to determine the resistance to attack by termites of a special grade of close grained heartwood redwood. (Fig. 17)

TESTS OF MORTARS FOR FOUNDATION WALLS

Tests of mortars and concrete of various different chemical and physical conbinations are also being conducted by the Bureau of Entomology to determine the most effective combination for foundations below the surface of the ground for the purpose of preventing penetration by termites. Certain termites subterranean in habit are able to dissolve certain grades of lime mortars. At Falls Church, Virginia, sixteen such test walls or panels were constructed in August, 1926. Other similar test walls have been built by the Bureau of Standards at Washington, D. C., and by the State Entomologist at Urbana, Illinois, during 1927 in cooperation with the Bureau of Entomology. These tests will be rather long time tests although certain grades of mortars have already failed. (Fig. 12)

REFERENCES

1926. Fullaway, D. T., Termites or white ants in Hawaii. The Hawaiian Forester and Agriculturist, Vol. XXIII, No. 3, pp. 68-88. July-Sept.

1926. Snyder, T. E., Prevention of damage by termites or white ants. Farmers' Bul. 1472, U.S. Department of Agriculture.

1926. Snyder, T. E., The biology of the termite castes. Quarterly Review of Biology, Vol. 1, No. 4, pp. 522-552.

1927. Snyder, T. E., Termites modify building codes. Journal of Economic Entomology, Vol. 20, No. 2, pp. 316-321.

1928. Snyder, T. E., How to prevent termite damage to buildings. Engineering News Record, Vol. 100, No. 7, pp. 274-276.

PROVISIONS FOR BUILDING CODES FOR INSURING PROTECTION FROM TERMITES AND DECAY

Wood or fiber products, when not impregnated with an approved preservative, shall not be placed in contact with the earth or within 18 inches thereof, excepting wood columns or posts over a concrete floor, which columns shall be provided with non-corroding metal or concrete base plates or footings 6 inches above the floor. This applies to steps, which shall be laid over a concrete base, projecting at least six inches beyond the supports of the steps.

Timber to be used in contact with the earth shall be thoroughly impregnated by a standard pressure process with coal-tar creosote or other equivalent preservatives. Timber should be completely framed before treatment, whenever possible, but when cutting after treatment is unavoidable the cut surfaces shall be thoroughly coated with coal-tar creosote or other equivalent preservative.

Masonry foundations and footings shall be laid in Portland cement mortar. Foundations built up of masonry units, whether hollow or solid, shall be capped below woodwork with at least 1 inch of Portland cement mortar, or the mortar and slate, or solid cemented nonoorroding metal, or other equally efficient seal.

In the case of frame buildings, a metal termite shield shall be provided, continuing completely around the top of the masonry foundation, including all pillars, supports, and piping, below the woodwork of the building, on both the inside and outside surfaces. Such a shield may be formed of a strip of nonoorroding metal (such as copper, zinc, or an alloy of copper 28%, nickel 67%, iron, manganese and silicon 5%), firmly inserted in the surface of the masonry, or between the foundation and the wood, with the projecting edge bent downward at an angle of 45 degrees and extending horizontally at least 2 inches from the face of the foundation. In masonry buildings this shield can be inset in the masonry at a height at least 18 inches above the ground.

Floor sleepers or joists imbedded in masonry or concrete, or laid in concrete which is in contact with the earth, shall be impregnated with an approved preservative.

Expansion joints between concrete floor and wall shall be filled with liquid asphaltum and the right angle joint covered with a sanitary cement mortar or Portland cement concrete finish of an arc of at least 2 inches in length.

The ends of wooden beams or girders entering masonry or concrete shall not be sealed in but shall be provided with boxes affording an air space at the end of the piece of not less than 1 inch at side of member, unless the ends of such timbers are impregnated with coal-tar creosote or other approved preservative.

Where there are spaces under floors near the earth, they shall be excavated so that there will be no earth within 18 inches of the wood, and they shall be provided with cross ventilation. Such ventilating openings shall be proportioned on the basis of 2 square feet for each 25 lineal feet of exterior wall, except that such openings need not be placed in front of such building. Each opening shall be provided with 20-mesh non-corroding metal screening, including windows in attics.

Where timber is used in roofs of the flat type, the roof shall, unless protected on the weather side with a covering impervious to water, have a slope and runoff sufficient to provide proper drainage.

All wooden forms on foundations shall be removed from masonry work within 15 days; grading stakes should be removed before laying concrete floors.